GOVERNMENT OF INDIA

DEPARTMENT OF HEALTH

Report of the Committee convened to consider the measures to be taken to prevent the creation of conditions favourable to the spread of malaria during the construction of roads and railways

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AGRICULTURE IN ECONOMIC DEVELOPMENT

1 INTRODUCTION

5.1.1 In this country, agriculture is the largest sector of economic activity. It provides not only food and raw materials but also employment to a very large proportion of the population. Being the dominant sector, the improvement or changes in the national output depend on the output in agriculture. For the same reason, it has to provide the capital required for its own development and make available surpluses for national economic development. In the early stages of economic development, the exports of primary produce earn valuable foreign exchange which can be used to import capital goods for the development of industry and infrastructure. For all these reasons, an improved and efficient agriculture is a necessity in agriculturally dominant economies. The economic history of the now developed economies amply demonstrates that improvement in agriculture preceded and paved the way for rapid strides in industry, transport and other non-agricultural activities.

5.1.2 While the development of agriculture seems to hold the key to the progress of the economy as a whole and should receive due emphasis, the linkage between agricultural and non-agricultural sectors also needs to be recognised. The interaction between agricultural and non-agricultural sectors facilitates the growth of both. The demand for

At the first meeting the Committee considered notes by Sir Gordon Covell and Major Senior White (Appendices I and II) specifying the chief features in railway and road construction likely to create conditions favouring the incidence of malaria and heard the views of the engineers present as regards the measures which might be taken to prevent such conditions from arising.

At the second meeting of the Committee the following documents were examined and discussed :—

1. Railway Board Circular No. 5233-W, dated 24th June 1946, addressed to all Government railways on the subject of antimalaria measures to be adopted during the railway construction.

2. Memorandum on borrowpits in land acquired temporarily for road construction by Mr. G. A. D. Cochrane, Consulting Engineer (Roads), prepared for the Central Roads Board meeting of 23rd September 1946 (Appendix IV).

3. Minutes of a meeting of the Transport Department on borrowpits held on 27th September 1946 (Appendix V).

4. Note by Sir Arthur Dean, Chairman, Delhi Improvement Trust, on construction of road embankments without creation of borrowpits (Appendix VI).

5. Note by Lt.-Col Afridi, Deputy Director, Malaria Institute of India, on the control of malaria among parties engaged in road and railway construction (Appendix VII).

1. Railway Board Circular No. 5233-W.

Sir Gordon Covell drew attention to a number of features in the circular which were unsatisfactory as regards malaria prevention, and suggested certain amendments.

Dr. Nichols undertook to recommend to the Railway Board that the circular should be amended on the lines suggested.

As the result of these recommendations a new circular No. P46G|147, dated 21st November 1946 was subsequently issued by the Railway Board in substitution of their circular No. 5232-W, dated 24th June 1946 with directions that this should be embodied in the Manual of Instructions for Construction Engineers (Appendix III). The amended circular conforms in general to the recommendations of the Committee.

2 and 3. Memorandum on borrowpits in land acquired temporarily for road construction, dated 23rd September 1946 by Mr. G. A. D. Cochrane (Appendix IV) and minutes of the meeting of a Departmental Committee of the Transport Department held on 27th September 1946 (Appendix V).

It was agreed that the issuing of a directive regarding the location, number and design of culverts in connection with road construction was desirable. Mr. Cochrane undertook to prepare such a directive for submission to the Roads Board.

The Committee adopted the conclusions reached by the Departmental Committee, adding a rider to the effect that special care be taken regarding the drainage of borrowpits at points of intersection between roads and railways and canals.

4. Note by Sir Arthur Dean on construction of embankments without creating borrowpits. (Appendix VI).

It was agreed that the profile of borrowpits advocated and used by Sir Arthur Dean in road construction in Delhi Province was the method of choice, but it was noted that the Department of Agriculture did not attach importance to the replacement of top soil in borrowpits of reasonable depth.

5. Lt.-Col. Afridi's note on the control of malaria among parties engaged in road and railway construction. (Appendix VII).

The measures for protection of survey parties and construction parties outlined in the note were approved.

6. The Committee adopted the following resolution moved by Sir Gordon Covell.

"No engineering project of any description should be undertaken without consideration of the malarial aspect and provision in the original estimates for necessary antimalaria works and for the protection of survey parties and of labour forces during construction."

II. Summary and recommendations.

The Committee considered the measures which should be taken for the prevention of the breeding of malaria-carrying mosquitoes in connection with borrowpits, culverts, quarry-pits and cuttings created during railway and road construction, and for the protection of survey parties, labour forces and other personnel engaged on such projects.

They made the following recommendations :—

A. *Culverts.*

1. The provision of culvert openings as usually made under railway and road banks should be more liberal than is the usual existing practice, wherever there is the least question of water backing up, and should be sufficient to provide for the occurrence of periodical heavy rainfall.

2. Culverts should be so designed that a lowering of the invert levels by approximately 5 feet could be effected if and when required without endangering the stability of the structure.

3. Revised engineering specifications should be drawn up in accordance with the above recommendations. These should apply to :—

(i) All new engineering constructions, including canal irrigation systems.

(ii) Existing structures which for technical engineering reasons need reconstructiou.

(iii) A limited number of existing structures which can be definitely demonstrated to constitute a direct source of severe malaria among the local population.

4. It is desirable that a directive such as has already been circulated by the Railway Board (Appendix III) be issued by the Roads Board regarding the location and design of culverts in road construction.

B. *Borrowpits*

5. The excavation of borrowpits withing built-up areas and for half a mile beyond their limits should be prohibited.

6. Elsewhere, the digging of borrowpits should be avoided wherever possible. Where earth can be obtained from no other source the following rules should be observed :—

(i) The profile of borrowpits advocated and used by Sir Arthur Dean in road construction in Delhi Province (Appendix VI) is the method of choice.

(ii) Adequate provision should be made for the drainage of all borrowpits into the nearest natural drainage channel.

(iii) Interconnecting drains between borrowpits should be at least 5 feet wide.

(iv) Margins of borrowpits should be kept straight.

(v) All "dead men", "matams" or other similar aids to measurement of earth excavated should be removed.

(vi) Particular care is necessary as regards the siting and depth of borrowpits in hilly country, on account of the danger of tapping seepage outcrops.

(vii) Special care should also be taken regarding the drainage of borrowpits at points of intersection between roads and railways and canals.

C. *Quarry-pits and Cuttings.*

7. Adequate drainage should in all cases be provided for quarry-pits and cuttings wherever these expose seepage outcrops.

D. *Protection of survey parties, labour forces and other personnel engaged in railway and road construction.*

8. Measures for the protection of all such personnel should be enforced on the lines laid down in Lt.-Col. Afridi's note (Appendix VII).

E. *Financing of antimalaria works.*

9. No engineering project of any description should be undertaken without consideration of the malarial aspect and provision in the original estimates for necessary antimalaria works and for the protection of survey parties and of labour forces during construction. A definite proportion of the cost of the project should be earmarked for this purpose.

APPENDIX I

NOTE ON MALARIA PROBLEMS CREATED DURING ROAD AND RAILWAY CONSTRUCTION.

By

Major-General Sir Gordon Covell, C.I.E., K.H.P., I.M.S.,
Director, Malaria Institute of India.

The principal features of railway and road construction which favour the spread of malaria are :—

(1) Interference with natural drainage by the provision of an insufficient number of culverts or of culverts incorrectly placed.

(2) The creation of borrowpits without provision for their drainage, either to obtain earth for embankments or in the process of quarrying for stone or gravel.

Antimalaria drainage differs in many respects from other engineering activities, the chief being that meticulous attention to details and continuous maintenance are all important. If these are neglected the scheme from the antimalaria view point may be a total failure. In the disposal of stormwater for instance, drainage measures may fail because whilst great attention is devoted to its rapid disposal, too little is given to the removal of all water after the storm has passed. Again, whilst a system of flat bottom drains may be perfectly effective in rendering an area fit for agricultural purposes, malaria may actually be increased unless a cunette is provided, or the bottom shaped and maintained as a shallow V.

It is only natural that such details should be entrusted to subordinates, whilst the senior engineers are apt to be engrossed by what are to them the more important phases of their work.

CULVERTS

In a recently published American text book on Mosquito Control by W. B. Herms, an Agricultural Entomologist, and H. F. Gray, a Consulting Civil Engineer, the following passage occurs :—

"Railroad or highway embankments with improperly placed culverts are typical obstructions. After long and sad experience the writers are convinced that it is only by accident that either a railroad engineer or a highway engineer ever places a culvert properly. Usually it is set too high, so that a pool or swampy area forms on the upper side of the embankment; occasionally it is set too low, so that water remains in the culvert itself.

"The bottom of the culvert should conform closely to the general ground surface gradient at the low point. To determine this, a profile should be taken along the bottom of the drainage way or depression for at least fifty feet, preferably one hundred feet beyond the toes of the future embankment and the culvert elevation and grade properly fitted to this profile."

(a) *Correct placing of culverts.*—The culvert should be placed along the line of natural channel or at low point. Its grade should follow the natural grade of the land. If the invert is level it will tend to become obstructed with gravel or dirt. If the grade is steeper than the natural grade a pool may form below it owing to scour. On the other hand, as noted above, if the upstream end of the culvert is too high it will cause ponding or a marsh above the embankment. This may have been done intentionally in order to prevent silting and thereby heavy maintenance cost.

(b) *Provision of an insufficient number of culverts.*—Where there are no other considerations involved there is a natural tendency to provide only that number of culverts which will ensure that the road or railway will not

be washed away or damaged by floods. This is insufficient for antimalaria purposes. *Any* interference with natural drainage will result in an increase of mosquito production and hence of malaria. Furthermore, it must be ensured that natural drainage will be unobstructed, not only under normal conditions, but also in years of abnormal rainfall and flooding. This applies particularly to those regions which are subject to periodic regional epidemics of malaria. A case in point is that of a triangular tract in the Punjab bounded on two sides by canals and on the third by a railway embankment. The canals were aligned parallel to the direction of natural flow and offered no obstruction to drainage. Stormwater was normally removed by the Hudiara Nala, a natural drainage channel passing under the railway line through a culvert. In 1908, a year of abnormal rainfall, a heavy precipitation falling on a soil already moistened by irrigation and previous rain resulted in a very high discharge. The culverts were insufficient to carry off the accumulation of stormwater, which headed up and inundated the greater part of the tract. The resulting inundation of obstructed stormwater soaked into the soil and raised the subsoil water table to ground level : it also filled every tank and depression with water, which provided prolific breeding places for malaria-carrying species of mosquitoes. A regional malaria epidemic of great severity associated with an exceptionally heavy mortality was the result of this combination of circumstances.

(3) *Design of culvert.*—Certain specifications have been laid down by American sanitary engineers to minimise the danger of mosquito breeding, e.g., that the cement used at the joints of the invert shall not be allowed to ooze up on the inside forming a dam and in consequence small pools of water, and that the floor shall have a circular cross-section with an ordinate distance of say 1|6th of the chord of the curve to provide for velocity sufficient during the dry weather to prevent mosquito breeding. But to the malariologist the views of J. L. Clarke, a distinguished sanitary engineer, put forward in the *Engineering News Record* of 1936, Vol. 117, p. 266 are of greater interest. He condemns the box culvert as a public menace on account of "the unpardonable dereliction in the design of a bottom which, being an integral part of the structure, may not be tampered with" and favours the substitution of a bottomless culvert which will allow the deepening of the stream bed.

He also criticises the "equalizer" culvert, i.e., one which has no outlet but simply permits water to stand at the same level on both sides of the road. "Its use in highway construction is an admission of failure. Standing water in borrowpits and roadside marshes should be drained as an integral part of highway construction. There is no good reason why land should not be purchased or condemned for drainage rights of way in the same manner employed to obtain road rights of way."

It would be of advantage from the malariologist's point of view if guiding principles could be laid down on these lines for road and railway construction engineers. It would also be helpful if a regulation were included for the provision of concrete aprons below culverts which would otherwise be likely to produce potholes.

Borrowpits.

Much controversy has centred around this subject. Undrained or improperly drained borrowpits are always a source of mosquito breeding, and often harbour the larvae of malaria-carrying species, more particularly in foothill tracts, and in coastal areas where they may be contaminated by salt or brackish water. They were the cause of much malaria during the Burma campaign, particularly on the Arakan front, where an enormous amount of labour was expended in filling them up. The very fact that in most cases they were eventually filled with soil locally obtained indicates that in these localities they need never have been made.

This is the first contention of the malariologist, i.e., that in many cases, perhaps in the majority of cases, the excavation of borrowpits is actually unnecessary. This has been demonstrated in the Delhi urban area which covers an area of about 65 square miles of country. At one time it was not possible to find a single borrowpit in the whole area, a claim which perhaps cannot be altogether substantiated at the present time. There is a natural tendency to take earth from a low point, because here it is softer and more easily excavated. But in many cases sufficient earth can be obtained by slicing it from elevations or hillocks. This may increase to some extent the cost of construction and maintenance, but it should be a recognised charge in the interest of public health.

If, however, the necessary earth cannot be obtained without creating borrowpits the following suggestions are put forward :—

(i) The practice advocated by Sir A. W. H. Dean in road construction, whereby after removing and placing on one side the upper 6 inches of soil a very broad shallow pit is made a few inches in depth and perhaps 20 feet wide. The topsoil removed, which is valuable as a manure, is spread over the bottom and the whole is ploughed along with the rest of the field by the cultivator. At the end of the season little or no sign of the borrowpit remains.

(ii) Instead of making irregular shaped isolated borrowpits, one broad pit is made alongside the road or railway in the form of a shallow drain, the water being discharged wherever possible into a natural nala or stream.

(iii) Where this cannot be done for reasons of scour, as for instance in foothill country where the gradient is too steep, drainage should be provided for each borrowpit into the nearest natural channel, or into one deep pit where the water can conveniently be treated with larvicide.

(iv) No borrowpits should be permitted within municipal limits. It is said that when the Agra-Delhi Chord railway was diverted in order to provide the site for New Delhi, two estimates were prepared for the construction of the embankment. One provided for the bringing in of earth from outside, whilst in the other it was to be obtained locally. The latter was naturally the less costly by several lakhs of rupees and was accepted on that account. A chain of enormous borrowpits was excavated on either side of the embankment which provided prolific breeding places for mosquitoes for the next 25 years. The cost of filling these pits, which was carried out in 1936 as an antimalaria measure, was considerably greater than the difference between the two original estimates.

On the other hand, the embankment carrying the branch line which carries coal to the Electric Power House from a point on the Agra-Delhi Chord line north of Purana Qila was constructed about 6 years ago without a borrowpit of any kind. This project, conceived purely for utilitarian purposes, was transformed into an effective antimalaria work as the result of close collaboration between the railway engineers and the malaria department, with a negligible increase in the cost of construction.

(v) A regulation exists on the B. and A. and B. N. Railways prohibiting the excavation of borrowpits between distant signals of stations. It is suggested that this rule should be applied to all railways in India.

Quarry—pits and cuttings.

Both of these are likely to expose seepages and thus produce ideal breeding places for malaria carrying mosquitoes. It is most important that adequate drainage be provided under such circumstances.

It may be objected that the adoption of the above suggestions will add to the cost of road and rail construction. It is contended that the inclusion of provision for antimalaria work is a legitimate charge on such projects and indeed on all forms of engineering construction, particularly in regard to canal irrigation, and that no engineering scheme should ever be undertaken without such provision. Antimalaria sanitation should be looked upon in the same light as the provision of water supplies, sewers and other essential public health requirements.

APPENDIX II

NOTE REGARDING MALARIAGENIC CONDITIONS CREATED DURING ROAD AND RAILWAY DEVELOPMENT.

By Major R. A. Senior White, Malariologist, B. N. Railway.

1. *Railway borrowpits.*—The General Manager, E. I. R. made a reference to me through may G. M. some months ago. To the best of my recollection I pointed out that the malariagenic status of borrowpits differed in various parts of India. In hill country borrowpits are particularly dangerous as they frequently tap sub-soil water, and in such seepages the virulent vectors of the *fluviatilis-minimus* group breed. *Per contra*, *A. philippinensis*, the vector of deltaic Bengal is said not to breed in borrowpits, though I am not disposed to regard this as proven beyond dispute. Between these two extremes borrowpits, however, surface-clear, produce *culicifacies*, the vector of most of India other than the eastern side, and, where weedy, *annularis*—the vector in particular of the Orissa Coastal plain. Borrowpits within 10—20 miles of the Bay of Bengal coast are frequently the breeding places of that most dangerous vector 4, *sundaicus*, whether such are clean or weedy ; in fact newly excavated pits appear to be especially favoured by this species.

Borrowpits, therefore, are nearly always dangerous, and if any other method of providing spoil for embankments can be devised, this is highly desirable. Village spleen rates on the Raipur-Vizianagram Rly., constructed 1926-31, appear to have risen considerably after the original surveys tabulated in Rly. Board Technical Paper 258, and this must almost certainly be a borrowpit caused phenomenon. However, the financial code dealing with earth-work measurements calls for measureable sized borrowpits with 'mattams' in proof of depth. The mattams provide additional 'breeding edge'. I believe that earth obtained by any other method of excavation has to be paid for at more expensive daily labour rates. If an alternative method of building and *maintaining* banks can be devised, its general acceptance will involve a change in the Financial Code.

2. The official B. N. R. construction manual of 1939 lays down "no borrowpits between the outer signals of stations". Henceforth this will simplify the problem of protecting individual stations, but will not greatly ameliorate the general Public Health problem of any district through which a railway may in the future be built.

3. Provincial Health Deptts. and Local Boards frequently issue notices in respect of malaria and mosquito nuisance attributed to railway borrowpits whilst ignoring those created by road building authorities, provincial or local. Considerable malaria hazards have during the war been created by the Aerodrome Branch of the Central P. W. D. Any regulation of earthwork enforced on the Railway Deptt. must therefore be simultaneously made applicable to other authorities.

4. Schemes are at times produced by Agricultural and Fishery Deptts. for utilizing borrowpits for food production. I have seen borrowpits utilized for rice cultivation on both the O. and T. and the E. I. railways. Whilst rice cultivation is seldom as dangerous as weedy borrowpits, a reference by the B. N. to the O. and T. Railway evoked the reply that the system had grave objections and was to be deprecated. I have recently raised the matter again in respect of E.I.R. borrowpits in Western Bengal. My report has not yet, however, been taken into consideration. I do not see how, under such conditions, banks can be periodically 'made up'.

5. Railway borrowpits are frequently leased out for fishing. This involves the objection that the lessees have the right to object to any form of larvicidal treatment, either by chemicals or by utilizing the newly announced method of planting water hyacinth for the control of *philippinensis* and *sundaicus*.

6. Draining or filling borrowpits is liable to evoke village objection, as the contained water is often bailed out to save a crop or to serve a second one in the dry season. If borrowpits do not exist *ab origine*, this difficulty cannot arise.

7. In my reply to G. M., E.I.R. mentioned in para. 1, I referred to the British railway construction method of 'cut and fill'. It was pointed out to me that this system is too costly for use other than where land is very expensive, which is not often the case in India. Even in England borrowpits, probably potentially malariagenic, exist on such lengths as Whitstable-Birchington (S.E.) and Bourne-Sutton Bridge (M. and G. N. Jt. Rly.) where there are no cuttings to provide the 'fill'.

8. *Culverts.*—The cost of a culvert under an embankment is directly related to its length. Engineers therefore tend to place the sill of a culvert higher than ground level, thus creating a dangerous pool on the upstream side.—They excuse this by pleading that with time the area below the sill will silt up to its level. Even when, which is not invariably the case, this ultimately occurs, malariagenic conditions are created that last some years. There is a good illustration of such a misplaced culvert in a book by Van Hovenberg, Anti-Malaria Engineer, St. Louis-South Western R. R., indicating that the Indian Engineers are not unique in this respect.

9. *Cuttings.*—These often expose seepages of the most dangerous kind. Only on the F. M. S. Govt. Rlwy. have I seen these dealt with by lateral and by vertical sub-surface drainage.

APPENDIX III

[*To be substituted for Railway Board's letter No.* 5233-*W., dated* 24*th June* 1946.]

GOVERNMENT OF INDIA.

Railway Department (Railway Board).

No. P46G|147. *Dated New Delhi, the* 21*st Nov.*, 1946.

To

ALL INDIAN GOVERNMENT RAILWAYS.

Anti-malarial Measures to be adopted during railway construction.

The Board have had under consideration the principles to be formulated for the avoidance of conditions which favour the spread of malaria produced as a result of rail constructions :—

(a) by the creation of borrowpits, either to obtain earth for embankments or in the process of quarrying for stone or gravel, wihout proper provision for their drainage ; and

(b) by the provision of culverts either insufficient in number, or placed incorrectly in respect to natural drainage.

BORROWPITS.

2. They, therefore, desire that in new line construction where the necessity arises for earth to be obtained by excavation of borrowpits for making up new embankments or for repairs to existing banks, the borrowpits should be so cut as to ensure that water does not remain stagnant in them. Where possible and practicable, the borrowpits should be left clean, free from 'dead men' and sharp edged, and extra expenditure not exceeding 1 per cent. of the cost of the earth work in any project may be incurred to achieve this. The bed level of these borrowpits should be so graded and profiled that water will drain off by drainage channels connecting one pit with another till the nearest natural drainage nullah is met with.

No borrowpits should be made anywhere within station or municipal limits or in the vicinity of station yards and it is presumed that most of the Railways have already issued instructions to this effect.

In regard to quarries, the Board desire that new quarries should, wherever possible, be so worked as to leave a natural drainage fall and that pockets where water may be accumulated should be avoided.

CULVERTS

3. The floors of culverts and minor bridges should be so designed as to avoid the formation of stagnant water on their upstream side.

The Board desire that where culverts have to be provided in new line constructions or the existing ones have to be re-built, they should be so designed, that the lowering of the invert levels by about 3′ to 5′ could be done if and when required without endangering the stability of the structure. The additional expenditure to be incurred for providing deeper founds to culverts should not however exceed 2 per cent. of the cost of structure.

Provision of adequate waterways should continue to be made in accordance with the present practice.

Care should continue to be bestowed in placing culverts suitably as regards location, elevation and grade.

STAFF FOR ANTIMALARIAL WORK.

4. The Board have also considered the necessity for antimalaria officers to accompany survey parties and the provision for these officers and staff should be considered on the merits of each case—especially in bad countries where malaria is known to be prevalent.

When submitting estimates, necessary provision should be made for these officers and staff if considered necessary. If, however, the country through which the new line construction is undertaken is free from malaria or it is accepted by the local medical authorities as country in which the incidence of malaria is low, no provision should be made for such officers

5. The above instructions of the Board should be embodied in the Manual of Instructions for Construction Engineers

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APPENDIX IV.

MEMORANDUM BY MR. G. A. D. COCHRANE, CONSULTING ENGINEER (ROADS) MEETING OF 23RD SEPTEMBER 1946.

Borrowpits in land acquired temporarily for road construction.

1. The earth required for embankments in road construction is obtained from one or more of 3 locations, namely :—

(a) By transfer from adjacent 'cuttings' along the road ;

(b) By the excavation of drains at the road land boundaries, or removal of local high spots between the embankment toe and the boundary ;

(c) From 'borrowpits' dug in land lying outside the road land boundaries.

This reference relates to item (c) namely BORROWPITS.

2. Whilst the land required for the functional purposes of the road is usually acquired outright, that needed for purely construction purposes, i.e., for borrowpits (and quarries) is either leased temporarily or acquired outright according as by the removal of such earth (or in the case of quarries other minerals) the land remains fit or becomes unfit for use for its original purpose.

This reference chiefly relates to what is known as temporary "acquisition".

3. Borrowpits can be objectionable in 3 main respects :—

(a) Unless they can be, and are, properly drained they increase the hazard of the incidence of malaria ;

(b) When in cultivated, or cultivable land, they reduce the fertility of the land by—

(i) removing the valuable surface tilth ;

(ii) reducing the depth of the soil layer suitable for root development ; and

(iii) increasing the liability to water logging (though, in the more arid tracts, the extra water held may actually be advantageous).

(c) They produce an unsightly appearance, though careful layout and control can reduce the effect.

This reference relates to effects (a) and (b)

4. For any given quantity of earth required in the road embankment, the deeper the borrowpit, the less the area of land that has to be operated upon.

The cost-rate per unit quantity of earth is usually constant down to depths of about 4 feet (assuming the nature of the soil does not change in that depth.) On the other hand such deep pits would—

(a) render the land unfit for further use ; and therefore,

(b) necessitate outright acquisition instead of temporary acquisition, thereby depriving the cultivator of his land for ever ; and

(c) generally increase the malaria hazard.

On the whole we may say that deep pits are the most economical, but should not be encouraged.

5. We have therefore to go in for shallow pits which—

(a) in any type of land, namely cultivated, uncultivated but cultivable, or non-cultivable waste, shall not increase the malaria menace ; and

(b) in cultivated and cultivable lands shall, as far as possible, preserve the cultivability.

In regard to (a), everything depends on the general local slope of the country, the location of the pits, and the feasibility of draining them. In some areas a depth of 2 feet might be a reasonable average ; in others a lesser depth would have to be prescribed if the hazard is to be avoided. Less depth means more land, and longer carriage, and therefore more cost. The point is, however, supported in the Nagpur Report which classed as deserving of particular attention a provision in a Highways Act "to discourage deep borrowpits as malaria inducing and dangerous to public health ; to enforce shallow pits in land temporarily acquired".

At least one Province (C. P.) already goes one step further, by prohibiting (through an Executive Instruction) the digging of any borrowpits at all within a town or village, while the Railways have a similar rule applicable to areas adjacent to railway colonies or railway stations. These health measures cause additional cost to the Road Authority through the extra cost of carriage involved.

In regard to (b) and more particularly in respect of land that is already under cultivation, we need not only relatively shallow pits which can generally be effaced into shallow depressions by ploughing ; we should also try to conserve the top soil to a depth of, say, 6 inches.

(*Note* :—It is not easy to *dig* to less than 6 inches depth : anything appreciably less amounts to *scraping*).

The process would then be :—

dig to 6 inches depth and remove to spoil banks;

excavate further to say 12 to 18 inches depth and deposit the earth in the road bank ; reduce the spoil (surface) earth in the pit, leaving a net depth of 6 to 12 inches. This is relatively a costly process. Land acquisition officers in taking cognizance of the reduction in damage accruing to the land, may reduce the unit area rate of compensation payable, but use will have to be made not only of the area allotted to excavation but also of additional area on which the spoil earth can be temporarily stacked. This reference relates mainly to (b) of this item.

6. The effect of these combined measures of shallow borrowpits, and preservation of tilth in cultivable ground, is shewn in the attached statement where 4 cases are compared. The rates approximate to some of those quoted by Bihar in their recent estimates for certain National Highways. It has, however, been assumed that there will be some reduction in the compensation payable for agricultural land when the top soil is to be replaced, and that the rate payable for land used for stacking only will be reduced even further.

It will be seen that the process involving the replacing of the surface soil can be an expensive proposition. On the other hand, if it is not replaced, the cultivator stands a good chance of incurring continued loss over a protracted period.

7. The Board is asked to consider this question of "*borrowpits in land acquired temporarily for road construction purposes.*" It may readily agree that, as against the malaria hazard—

(a) shallow pits should be the rule, whether in cultivated or in uncultivated land ;

(b) a depth of 12 inches is considered to be the maximum suitable in open country except in purely waste land and where the pits can be thoroughly drained ;

(c) in areas within say 1|2 mile of a built-up area, the depth of pits should not exceed 6 inches, and in fact, except in cultivated ground, the digging of any pits within such zones should be discouraged altogether.

The Board may advise on the even more important principle of *replacement of top soil in cultivated areas used temporarily for borrowpits.* The extra cost is appreciable and in the case of National Highways, it will fall on the Centre. The Board has to decide whether to recommend the principle for general adoption on National Highways in all Provinces (and States), whether with or without the provision that Provinces will follow the same principle when constructing their own roads. If the Board is unable to come to an immediate decision on this matter (a reference to the Department of Agriculture may, for instance, be necessary) it is asked to advise on the particular case of Bihar in whose estimates for land and earth work for National Highways such provision is now being made ; these estimates cannot be approved and work cannot start unless a decision is reached. An unfavourable decision is apt to produce undesirable repercussions. An alternative is to ask Bihar to prepare a proper case by going into the financial and community effects in more details and by defining their own general policy in this regard.

BORROWPITS IN TEMPORARY LAND

Alternative costs per mile of road, assuming an average earth "borrow" of 120 c. ft.

Serial No.		Case I. (Deep pits).	Case II. (Shallow pits—replacements	Case III. (Shallow pits—cultivated—rural.	Case IV. (Very shallow pits cultivated—near urban).
1	Average gross depth of pit ..	1·0	1·0	1′ 6″ } Effective depth 1′0″	1′ 0″ } Effective depth 6″.
2	Depth of surface soil replaced..	*Nil*	*Nil*	6″ }	6″ }
3	Area of land affected—				
	(*a*) by excavation; ..	$\frac{120 \times 5280}{4} = 158400$ FS = 3·62 Ac.	$120 \times 5280 = 633600$ FS	14·5 acres.	14·5×2=29·0
	(*b*) by stacking surface soil to say 3 ft. height.	*Nil*	*Nil*	$\frac{14 \cdot 5}{6} = 2 \cdot 4$	$\frac{29 \cdot 0}{6} = 5 \cdot 0$ say
4	Acquistion, temporary of permanent.	Permanent.	Temporary	Temporary	Temporary
5	Rate per acre (per year for temporary)—				
	Type 3 (*a*)	1145	165	140 } Assumed	140 } Assumed
	Type 3 (*b*)	....	....	100 }	100 }
6	Number of years of occupation temporary land.	..	2	2	2

1	2	3		4		5		6	
7	Total cost of land—								
	Type 3 (*a*)		4145	2×165×14·5=4788		2×140×14·54=4060		2×140×29·0=8120	
	Type 3 (*b*)	....		....		2×100×2·4 = 480		2×100×5·0 =1000	
	Total ..		4145		4788		4540		9120
8	Quantity of earthwork—								
	(*a*) placed in road ..	120×5280 = 633,600		633,600		633,600		633,600	
	(*b*) placed in spoil ..	*Nil*		*Nil*		316,800		6633,600	
9	Cost of this earthwork—								
	(*a*) in road @ 10%o ..	6336		6336		6336		6336	
	(*b*) in spil @ 7/- %o ..	....		....		2118		4336	
	(*c*) from spoil back to pit @ 7/- %o	....		....		2118		4236	
	(*d*) Total (*a*) to (*d*) ..		6336		6336		10,572		14,808
10	Total cost of land plus earthwork 7+9 (*d*).	10481		11,174		15,114		25,928	
11	Percent excess on Class I ..	....		6.6		44		148	

APPENDIX V.

EXTRACT FROM MINUTES OF A MEETING HELD ON THE 27TH SEPTEMBER, 1946 IN ROOM No. 146, NORTH BLOCK, IMPERIAL SECRETARIAT BUILDINGS, TO DISCUSS THE QUESTION OF BORROWPITS IN LAND ACQUIRED TEMPORARILY FOR ROAD CONSTRUCTION.

The following were present :—

Mr. D. D. Warren, C.I.E., M.C., I.C.S., Secretary to the Government of India, Transport Department.

Mr. M. K. Sen Gupta, C.I.E., Financial Adviser, Communications.

Mr. G. A. D. Cochrane, I.S.E., Consulting Engineer to the Government of India (Roads), Transport Department.

Mr. K. S. Misra, I.C.S., Deputy Secretary to the Government of India, Transport Department.

Major General Sir Gordon Covell, C.I.E., K.H.P., I.M.S., Director, Malaria Institute of India, Health Department.

Rai Bahadur K. C. Mazumdar, Director, Agricultural Machinery, Agriculture Department.

Mr. H. D. Awasty, Deputy Director, Civil Engineering, Railway Department (Railway Board).

Mr. K. Ranganathan, Assistant Secretary to the Government of India, Transport Department.

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CONCLUSIONS

(a) *In cultivable land* :—

(i) if the depth of borrowpits was limited to a maximum of 9 inches, the productivity would not ordinarily be seriously impaired for any undue period ;

(ii) where the circumstances were such as to necessitate deeper pits, a net depth of about 1 foot might be permissible in open country, provided the rate of compensation was adjusted to suit the additional period over which the productivity might be impaired. In special circumstances it might be a suitable and economical proposition to retain the top soil for replacement in the pits ;

(iii) the net depth of pits within half a mile of a built up area in a town should ordinarily be limited to six inches ;

(iv) the beds of the borrowpits should be left clean, and free from all "dead men", "matams" or other similar aids to the measurement of the depth of earth excavated ;

(v) from the aspect of the incidence of malaria, a depth of six to nine inches would not be objectionable, provided the pits were of regular shape and properly drained.

(b) *In waste land* :—

(i) from the aspect of the incidence of malaria the pits in open country should be either relatively shallow, so that they would dry out quickly, or relatively very deep and narrow so as to keep the length of shore line to the minimum : deep pits should, however, be capable of being flushed and drained ; physical objections to deep pits were that they were dangerous to cattle and that they soon become unsightly through the sides slipping in.

(ii) pits within half a mile of a built up area in a town should ordinarily not exceed 6 inches in depth ;

(iii) no borrowpit should be dug within a built up area ;

(iv) particular care was necessary in the siting and depth of borrowpits in hilly country against the possibility of tapping seepage water.

(c) *In deltaic areas and areas liable to inundation* :—

fairly deep borrow pits were unobjectionable provided they could be easily drained.

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APPENDIX VI

NOTE BY SIR ARTHUR DEAN, CHAIRMAN, DELHI IMPROVEMENT TRUST, ON CONSTRUCTION OF ROAD EMBANKMENTS WITHOUT CREATING BORROWPITS.

The method which has been successfully followed in Delhi Province for the construction of many miles of new metalled and painted road consists of determining the quantity of earth needed for the embankment. The quantity was got out for every furlong or more closely if the height of the embankment changed rapidly. The formation width was 30 ft. made up of 12 ft. metalled and painted surface and 8 ft. earthen berms on each side. The side slopes were at 1 : 5. This gentle slope was adopted (a) to reduce the danger to carts forced off the formation by motor traffic, (b) to reduce the damage caused by rain in cutting gullies in the bank. The average height was 2 ft. 6 inches above field level. As however most of the roads followed pre-existing village cart tracks which had worn well below the natural surface extra earth was needed.

The nature of the land either side of the acquired road width was noticed on the plan, waste, dry cultivation, wet cultivation, etc., and the width needed to get the required quantity assuming a uniform depth of cut of 1 ft. only was wanted. A decision was then taken as to whether the amount required should be taken equally from both sides or whether particularly valuable land should be omitted. Waste land and high mounds were naturally first choice.

The upper 6 inches of soil which carries the accumulated manure of years of cultivation was removed and stacked outside the area to be excavated in stacks 10 ft. average width and 4 ft. high finished with 1 : 1 slopes and as long as necessary (Cross section 40 s. ft.).

The soil below this was excavated 1 ft. deep and the clods spread on the formation width of the road, broken and spread in 6 in. layers consolidated with rammers or sheep foot rollers until the formation height was attained.

As lengths of 1 mile or other convenient lengths of the road width were completed the whole excavated area was ploughed up and the top soil spread over it and harrowed in. This was done by the local cultivators on a piece work basis ; they did not like having it done for them by outside contractors.

By postponing the work so that it started after the crops had been gathered in and taking care to complete the work before the preparation of the tilth and spreading of manure for the next harvest had to start, no very serious interference with agricultural operations took place and instead of payment having

to be made for temporary or even permanent acquisition, only compensation for loss of use of the land for at most one season was necessary. This went a good way towards meeting the higher cost of excavating in this manner.

For the small quantities of earth needed to make up the embankment as it is washed and worn away under the influence of the monsoon and traffic, collecting the earth dug out during the regular clearance of drains designed to intercept drainage running off the fields and bringing it to the nearest culvert was found sufficient. This was done to a template so as to avoid low-lying spots holding water.

APPENDIX VII.

CONTROL OF MALARIA IN PARTIES ENGAGED ON ROAD AND RAILWAY CONSTRUCTION.

By Lt.-Col. M. K. Afridi, I.M.S., Deputy Director, Malaria Institute of India.

1. *Responsibility.*—Malaria protection should be laid down as a policy of the administration and all officers should be instructed to co-operate.

The engineer in-charge of construction should be made responsible for initiating all measures for the prevention of malaria. For this purpose he should make adequate provision for the requisite antimalaria personnel, equipment and stores.

2. *Antimalaria staff.*—The size and composition of the antimalaria staff will vary with the magnitude of the project and the degree of malaria existing in the area in which road or railway construction is contemplated. In most projects traversing malarious regions it will be necessary to provide not only for the control of malaria, but for a preliminary malaria survey. This survey may be entrusted to a railway malaria officer or to an officer borrowed from the provincial antimalaria organization. Alternatively, it may be necessary to appoint a whole time medical officer trained in malaria work, who after conducting the survey would take charge of the control measures approved by the engineer in charge In case of any special difficulties, the Director Malaria Institute of India should be approached for assistance.

The essential point is that the survey should be carried out in the earliest possible phase of planning, preferably at the time when the engineering survey is in operation. This will enable the engineer in charge and the malariologist to prepare their plans in unison and to decide as to the order in which work is to be carried out, relegating the work on sections traversing highly malarious areas to months when the malaria season is at its lowest. It will also ensure that the staff, equipment and stores, which normally take time to collect, are in full working order before the actual construction begins.

3. *Methods of control.*—The following are the principal measures of control which apply particularly to the conditions under which parties engaged on road and railway constructions are normally housed :—

(a) *Site selection.*—The importance of selecting a proper site for a camp cannot be over-emphasised In many instances, a careful search is rewarded by the discovery of a site relatively free from malaria, though it may be situated only a few miles away from a highly malarious one. In areas where malaria is uniformly high, certain sites may be easier to control than others.

While a decision on these points can be arrived at only after a consideration of the local terrain, etc., the following principles should invariably be observed :—

(i) Camps should be fixed at least one mile away from the nearest local habitations.

(ii) The sites for camps should be selected well in advance so that the antimalaria staff can initiate spraying and other preventive measures in each camp before it is occupied. For the same reason the malaria officer should be informed about the closing and opening of different camps at least one to two weeks in advance.

(iii) The sites should be clearly defined and no one allowed to erect shelter or tents outside the perimeter previously fixed.

(iv) If in the selection of a site the antimalaria requirements conflict with other needs such as of watersupply, food, etc., the antimalaria viewpoint should be given preference, especially in camps located in malarious regions.

(b) *Spraying with D.D.T.*—It is envisaged that in the construction of roads and railways, camps will have to be opened and closed frequently. Under these conditions, spraying with D.D.T. should be looked upon as one of the most important measures of control. The exact method of applying D.D.T., namely whether in the form of indoor residual or outdoor barrier spray will depend upon the length of time a camp is expected to be occupied. The former would be the method of choice if the camp is stationary for longer than 3 months, while the barrier spray should be reserved for camps occupied for a shorter period. Barrier spray consists of applying D.D.T. solution lightly once a fortnight at a dosage of 3 gallons per acre to (i) the outer surface of the buildings and tents, (ii) the ground surface between buildings and tents, and (iii) vegetation and ground surface for a distance of 50 yards around the camp.

(c) *Antilarval measures.*—These are indicated only in large camps which are likely to remain occupied for a period of six months of the malaria season or longer. Antilarval measures should be carried out along the usual lines, but drainage should be restricted to such breeding places as cannot be effectively dealt with by larvicides.

(d) *Suppressive treatment.*—Suppressive drugs are effective only if they are regularly taken. Their use in the first instance should therefore be confined to the superior staff, and to those who can be relied upon to take the drug as instructed. The labour force may however be placed on suppressive treatment, if arrangements for the strict supervision of administering the drug exist, particularly if an epidemic has broken out and is hampering the progress of the project.

(e) *Personal protection measures.*—The practical difficulties in enforcing these measures in a large contractor's labour force are so many that attempts to enforce them are unlikely to succeed. In the case of superior staff however it should be possible to instruct them to use mosquito-nets and repellents correctly and regularly.

4. *The Selection of appropriate measures of control.*—Factors which influence the selection are :—

(a) the size of the party ;

(b) the length of occupation of a camp and the stage of the malaria season at which it is occupied ; and

(c) the habits of the local malaria carrier mosquitoes.

For small mobile survey parties who are not expected to remain in one camp for longer than 10 to 14 days at a time, the selection of a site one mile away from the nearest local habitation should afford adequate protection, provided all members of the party remain inside the camp and are not allowed to visit local villages and houses from dusk to sunrise. In these parties the use of mosquito-nets and suppressive drugs could also be enforced, as it would be possible to provide the necessary supervision. The application of D.D.T. will necessitate a supply of sprayers and stores and the instruction of spray-gangs into the proper method of application. If the above conditions can be fulfilled this method of protection could also be utilised. Antilarval measures, on the other hand, would be impracticable and are not recommended.

In labour camps of any size which are likely to be occupied for less than 2—3 months, chief emphasis should be laid on proper selection of the camp site and efficient application of D.D.T. Personal protection and suppressive treatment would be applicable only to the superior staff. Antilarval measures should not be attempted. If labour is accommodated in ballast trains the latter should be treated as a camp, both in regard to its siting for the night and the application of D.D.T.

If labour is working at night, the site of the work should similarly be treated with D.D.T. on the principle of a barrier spray.

In large camps accommodating a considerable labour force which are stationary for six months or longer, the aim should be to provide control by antilarval measures, supplemented by the regular use of D.D.T. either over the entire camp or in the tents and shelters situated on the periphery. Should a camp be occupied in the middle or towards the end of the malaria season, it may not be possible to enforce antilarval measures in time to be effective. In these circumstances, it would be advisable to concentrate on D.D.T. spraying and to provide for the necessary antilarval control for the next malaria season.

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